Lebedeva Darina Yurievna
Student
Ural Federal University named after the first
President of Russia B.N. Yeltsin
Russia, Ekaterinburg
Academic supervisor: Ponomareva Elena Vladislavovna

WAYS TO OPTIMIZE THE ENERGY CONSUMPTION IN WIRELESS SENSOR NETWORKS

Abstract. *At the moment, wireless sensor systems are gaining great popularity, they are quite easy to install, since they do not require a wired power supply. The article deals with the issue of energy consumption and energy efficiency of nodes of wireless sensor networks. Several methods have also been proposed to optimize networks and increase the elements lifecycle.*

Keywords: *wireless sensor networks, power consumption reduction, energy efficiency, data collection scheme, topology.*

Лебедева Дарина Юрьевна
Студент
Уральский федеральный университет имени первого
Президента России Б. Н. Ельцина
Россия, г. Екатеринбург
Научный руководитель: Пономарева Елена Владиславовна

ПУТИ ОПТИМИЗАЦИИ ЭНЕРГОПОТРЕБЛЕНИЯ В БЕСПРОВОДНЫХ СЕНСОРНЫХ СЕТЯХ

Аннотация. *На сегодняшний момент набирают большую популярность беспроводные сенсорные системы, которые достаточно просты в установке,*

так как не требуют проводного питания. В статье рассматривается вопрос энергопотребления и энергоэффективности узлов беспроводных сенсорных сетей. А так же предложено несколько методов по оптимизации сетей и увеличения срока службы элементов.

Ключевые слова: *беспроводные сенсорные сети, снижение энергопотребления, энергоэффективность, схема сбора данных, топология.*

Introduction

Wireless sensor networks (WSN) are common in many areas of our lives. They are used in agriculture, medicine and various control systems. One of the main problems in the implementation of wireless sensor networks is providing sensors with energy.

A wireless network is made up of many small sensors. Since the size of these sensors is limited, therefore, resources are also limited. One of these resources is the limited power supply resource of the node. Without electricity, sensors will not be able to transmit and receive information; the communication between the nodes and the server will be broken.

There is another problem here. Frequent replacement of sensors and batteries is economical. Consequently, improving the energy efficiency of nodes of wireless sensor networks is a hot topic for many researchers, and analysis of energy consumption and its optimization is a promising direction not only in the WSN, but also in many other wireless networks.

Energy consumption analysis

The first stage is the network installation. Energy consumption is critical for most sensor networks at this stage. When deploying networks, a trade-off is usually used: for less power consumption, a small number of nodes are used over a long distance. However, if the nodes cannot take part in the initialization (for example, they are too removed or damaged), then this approach is a waste of energy. In this case, there is a method of setting the correct topologies.

The energy of the network node is spent on powering the sensor (sensors), a microcontroller with memory, which processes the information received from the sensor, as well as on a radio transceiver. In this case, the bulk of energy is spent on communication (receiving, listening and transmitting data), and not on processing or storing data. Therefore, for information collection networks with intensive information exchange, it is advisable to take measures to increase energy efficiency. For example, use special data collection schemes.

Optimization methods

There are many approaches and system solutions to improve the energy efficiency of the WSN. Let's consider some of them.

- *Network topology*

Traffic flows and their uniformity of distribution in the network significantly depend on the choice of topology. The “star” topology is the simplest topology to configure. The nodes are directly connected to the base station. The disadvantage of this topology is its low flexibility and limited scope. Due to the lack of relaying, this topology has high energy efficiency rates [1].

The main advantage of the «bus-star» scheme is the simplicity of connecting new nodes, and the disadvantages are low reliability (failure of the switch paralyzes the entire network) and low performance [2]. Repeaters have a high load, which is why they quickly fail, isolating the end nodes.

In a «multi-cell» topology, all nodes are routers. Networks with such a topology are reliable, but the average power consumption of nodes increases and its calculation becomes more complicated, since it is necessary to consider the total network traffic, that is, take into account both data packets, the source of which is the node itself, and the packets that it receives and transmits, performing repeater functions. Consequently, the battery life of a node will significantly depend on its position in the network topology and the direction of network traffic.

- *Data collection schemes*

Several experiments show that the cost of transmitting one bit of information is equivalent to the cost of performing a thousand operations [3]. Therefore, most

algorithms for reducing power consumption are based on reducing the amount of transmitted data. Several data acquisition schemes have been introduced to reduce power consumption:

1) Hierarchical approach: nodes should be equipped with different types of sensors. Each sensor has its own specific accuracy and power consumption. The system automatically determines which sensor to activate in order to achieve a compromise between accuracy and power consumption;

2) Adaptive approach: the amount of data for transmission and the available battery charge of the nodes are calculated, as a result, a route is chosen through the nodes with the highest battery charge;

3) Data aggregation method: one of the nodes of a network section becomes an aggregator. When the coordinator needs to get averaged indicators from a certain section of the network, he turns to the aggregator, which in turn collects data from all the nearest nodes, processes it and sends it to the coordinator. Thus, the cost of not transferring information is much lower than when each node sends its indicators to the coordinator;

4) Various schemes that minimize the number of measurements need to be taken from the sensors [4].

- *Monitoring the status of nodes*

The node can be in one of two modes: activation or sleep. Nodes switch between modes based on network activity and this behavior is known as duty cycle. The duty cycle can be defined as the ratio of the time that a node is active over its entire lifetime. There are two ways to reduce the duty cycle. The first approach is to reduce the number of nodes involved in forwarding and routing packets. This will ensure that nodes not currently needed for transmission will sleep. It has been empirically proven that the topology control circuit reduces power consumption by 50%. The second approach is to use MAC protocols TRAMA, BMAC and ZMAC using wake-up scheduling schemes.

Conclusion

Energy consumption is a key issue in improving the quality of the WSN, therefore, the problem of calculating it is paramount when creating such networks. This article examined the main points of work that cause a large consumption of energy. In addition, a set of measures was proposed, including network planning schemes and data collection schemes.

REFERENCES

1. V. Olifer, Computer networks. Principles, technology protocols: Textbook for universities. – 2006. – Text: electronic. – URL: https://www.computer-networking.info/1st/cnp3.pdf (Reference date 06.12.2020).

2. S. Baskakov, Estimation of energy consumption of wireless nodes in MeshLogic networks, Wireless technologies. – 2010. – Text: electronic. – URL: http://www.meshlogic.ru/data/publications/MeshLogicEnergy.pdf (Reference date 06.12.2020).

3. V. Raghunathan, C. Schurgers, S. Park, Energy Aware Wireless Sensor Networks. – 2002. – Text: electronic. – URL: http://graphics.stanford.edu/courses/cs428-03-spring/Papers/readings/Physical/ raghunathan_sp_02.pdf (Reference date 06.12.2020).

4. E. Abbasov, Indicators of wireless technologies for monitoring the quality and management. – 2017. – Text: electronic. – URL: https://www.technologicalvestnik.com/jour/article/view/307/467 (Reference date 07.12.2020).